

Insulin and Insulin Therapy

I. INDICATIONS

Always used in patients with type 1 diabetes or DKA (diabetic ketoacidosis) and may be required in patients with type 2 or gestational diabetes

II. MECHANISM OF ACTION:

Transports glucose into cells, promotes glycogen storage, and inhibits fat and protein breakdown

III. SOURCES:

- A. Human insulin, insulin analog: recombinant DNA technology
- B. Porcine insulin

IV. PREPARATIONS:

- A. Strength: U-100 (in the U.S.)
- B. Type and Action (see Insulin Action Times - page 82 - for description)

V. ABSORPTION OF INSULIN:

May vary with each patient because of:

- A. Source of insulin: porcine or human (porcine insulin tends to have a longer duration of action)
- B. Manufacturer: Eli Lilly or Novo Nordisk (avoid alternating manufacturers)
- C. Injection site: abdomen, arm, thigh, buttocks (listed in order of most rapid absorption)
- D. Temperature: cold insulin is absorbed more slowly
- E. Exercise or massage of injection site increases rate of absorption

VI. DOSING:

- A. Attempt to mimic body's normal secretion of insulin
- B. Examples of individualized insulin regimens
 1. Intermediate- or long-acting insulin daily or twice daily
 2. Intermediate- or long-acting insulin mixed with rapid- or short-acting insulin twice daily.
 3. Short- or rapid-acting insulin three times daily during the day and intermediate- or long-acting insulin at bedtime.
 4. Long- or intermediate-acting insulin twice daily and short- or rapid-acting insulin with meals
 5. Insulin-pump basal rates and premeal and supplemental boluses

VII. TIME OF ADMINISTRATION:

- A. Will vary depending on type of insulin (e.g., lispro & aspart are given within 5-15 minutes of meal; all other insulins are given approximately 30 minutes prior to meal)
- B. May also vary according to blood glucose result (e.g., if glucose is $>200\text{mg/dl}$ (11.1 mmol/l), administer injection and wait 45-60 minutes before eating; if glucose is $<80\text{mg/dl}$ ($<4.4\text{ mmol/l}$), first treat appropriately, then give insulin at time of meal or after eating)

VIII. EQUIPMENT:

- A. Syringe (1/4 cc, 3/10 cc, ½ cc, 1 cc; short needles available for children and thin adults)
- B. Pen injector
- C. Pump

IX. INSULIN ADMINISTRATION GUIDELINES:

- A. Preparation, single dose
 - 1. Wash hands
 - 2. Be sure insulin is at room temperature before using (may warm prepared syringe between hands)
 - 3. Clean rubber stopper with alcohol
 - 4. If using cloudy insulin, roll vial to mix, do not shake
 - 5. Draw air into syringe equal to the amount of insulin being withdrawn (equalizes pressure)
 - 6. Insert needle into stopper
 - 7. Inject air into vial
 - 8. Invert vial
 - 9. Fill syringe with insulin
 - 10. Clear air bubbles
 - 11. Check dose before administering
- B. Preparation, mixed dose
 - 1. Wash hands
 - 2. Be sure insulin is at room temperature before using (may warm prepared syringe between hands)
 - 3. Clean rubber stopper with alcohol
 - 4. If using cloudy insulin, roll vial to mix, do not shake
 - 5. Inject air into cloudy insulin first, then remove needle
 - 6. Draw air into syringe again
 - 7. Inject air into clear vial again
 - 8. Invert vial

- 9. Fill syringe with clear insulin first
- 10. Clear air bubbles
- 11. Check dose
- 12. Invert cloudy vial
- 13. Fill syringe with cloudy insulin to a combined total of clear and cloudy insulin
- 14. Check dose before administering

- C. Injection Sites (from the order of most rapid to slowest absorption)
 - 1. Abdomen has best absorption and is preferred site
 - 2. Upper arm and outer aspect (not deltoid)
 - 3. Thigh
 - 4. Buttocks/flank
- D. Technique
 - 1. Wipe skin with alcohol and allow to dry
 - 2. Pinch skin
 - 3. Insert needle slowly at 90 degree angle all the way to hub of syringe; use 45 degree angle for ½ inch needle or use short needle if patient is thin or a child
 - 4. Gradually release pinch as insulin is being injected
 - 5. Pull needle out at same angle as inserted (do not rub injection site after removal of needle)

X. STORAGE:

- A. Refrigerate unopened insulin (will be good until the expiration date on the vial)
- B. If using vial of insulin within 30 days of opening; may store at room temperature (>36° F and <86° F); insulin expires after 30 days at room temperature.

XI. MIXING INSULINS:

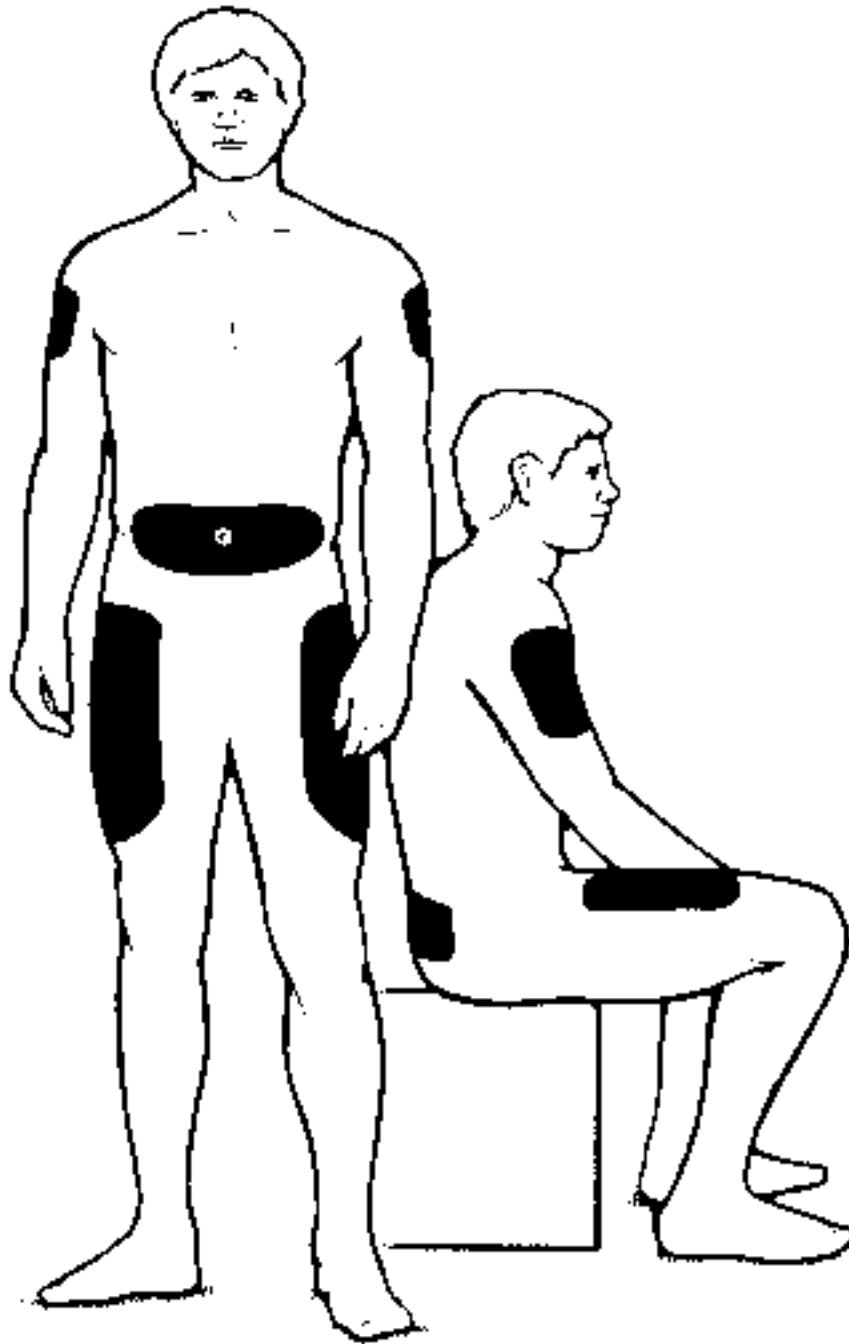
- A. NPH and short-acting insulin formulations when mixed may be used immediately or stored for up to 2 weeks
- B. Mixing of regular and lente is not recommended unless injected immediately after preparation; binding action of regular and lente begins immediately and effect of regular may be blunted
- C. Phosphate-buffered insulin (i.e., NPH and Velosulin) should not be mixed with lente
- D. Velosulin BR and NPH can be mixed

XII. COMPLICATIONS OF INSULIN ADMINISTRATION:

- A. Hypoglycemia
- B. Allergic reaction (local/systemic)
- C. Lipohypertrophy (thickening of subcutaneous fat at injection site)
- D. Lipoatrophy (thinning of subcutaneous fat at injection site)

Adapted from: Ballard AM, 2000. *Insulin and Insulin Therapy*. The Diabetes Ready-Reference Guide for Health Care Professionals. American Diabetes Association.®

Injection Sites



Adapted from: Funnell MM, Arnold MS, Barr PA, Lasichak AJ 2000. *Injection Sites*. "Life With Diabetes". American Diabetes Association, p191.

Insulin Action Times

There are three characteristics of insulin. These are:

Onset – the length of time before insulin reaches the bloodstream and begins lowering blood sugar.

Peak Time – The time during which insulin is at its maximum strength in terms of lowering blood sugar levels.

Duration – How long the insulin continues to lower blood sugar.

Storage and expiration dates also need to be taken into consideration.

Storage - Opened vials may be left at room temperature for 28-30 days after opening, or as indicated on package. Avoid exposure to extreme temperatures. Unopened vials should be stored in the refrigerator and are good until the expiration date on the package.

NOTE: Lantus must be refrigerated at all times, whether vials are opened or unopened.

Expiration Date - Make sure that the insulin that is supplied will be used before its expiration date.

Below you will find a table describing the insulin types with their comparative action times.

Types of Insulin by Comparative Action

Animal or Human	Insulin Type	Onset	Peak (Hours)	Usual Effective Duration (Hours)	Usual Maximum Duration (Hours)
Animal	regular	0.5 – 2 hours	3 – 4	4 – 6	6 – 8
	NPH	4 – 6 hours	8 – 14	16 – 20	20 – 24
Human	insulin aspart	5 – 10 minutes	1 – 3	3 – 5	4 – 6
	insulin lispro	< 15 minutes	.5 – 1.5	2 – 4	4 – 6
	regular	0.5 – 1 hour	2 – 3	3 – 6	6 – 10
	NPH	2 – 4 hours	4 – 10	10 – 16	14 – 18
	lente	3 – 4 hours	4 – 12	12 – 18	16 – 20
	ultralente	6 – 10 hours	---	18 – 20	20 – 24
	insulin glargine	1.1 hours	---	24	24

Please Note: Types of insulin are listed in more detail in the Reference Section at the back of this manual.

Adapted from: *Diabetes Forecast*, 2004 Resource Guide, Volume 57, Number 1, Pages RG 16-17. "Diabetes in Children A Resource Guide for School Personnel", 2002, Illinois Department of Human Services. <http://www.iasn.org/diabetes.pdf>.

Insulin Delivery Systems

Syringes...pens...pumps...inhaled insulin...they all do the same thing - deliver insulin. These items deliver insulin into the tissue so it can be used by the body. This category also includes injection aids - products designed to make giving an injection easier.

Syringes

Today's syringes are smaller and have finer needles and special coatings that work to make injecting as easy and painless as possible. When insulin injections are done properly, most people discover they are relatively painless.

Points to Consider for Optimal Insulin Delivery by Syringe

- The syringe being used should be the right size for the insulin dose.
- It should be easy to draw up and visualize the dosage (devices are available to make this task less complicated).
- Shorter, smaller needles are available which allow for ease of administration.

Insulin Pens

There is a wide range of insulin pen options available. The pens can be an excellent option when children need a single kind of insulin. They can make taking insulin much more convenient. Some children find the pen needles make injection more comfortable.

Pumps

Insulin pumps are computerized devices, about the size of a beeper or pager, which you can wear on your belt or in your pocket. They deliver a steady, measured dose of

insulin through a cannula (a flexible plastic tube) with a small needle that is inserted through the skin into the fatty tissue. The cannula is taped in place - not the needle. Insulin pumps may be worn during most athletic activities.

The pump may be placed on one of several sites on the body, including the abdomen, buttocks, thigh, or arm.

Advantages of the Pump

- Greater flexibility of meals, exercise, and daily schedule
- Improved physical and psychological well being
- Smoother control of blood glucose level
- Lower glycosylated hemoglobin

Disadvantages of the Pump

- Risk of infection at catheter site
- More frequent hypoglycemia
- Risk of ketosis and ketoacidosis
- Constant reminder of diabetes

Responsibilities of Pump Wearer

- Must be willing to test blood sugar a minimum of 4 times/day
- Must learn how to make adjustments in insulin, food, and exercise in response to those test results
- Must respond to blood sugar readings
- Troubleshooting pump for high or low blood sugars readings
- Keep back up insulin, syringe or pen, and pump supplies available at school and home

Inhaled Insulin

Inhaled insulin is a new type of insulin delivery system that has recently completed clinical trial testing. Though the product has not had final approval by the FDA for public marketing, some children are currently using this insulin delivery system from their trial participation.

Information will be forthcoming on the advantages and disadvantages of inhaled insulin, once it has completed FDA approval.

Adapted from: "Children with Diabetes: A Resource Guide for Schools", 2001, New York State Department of Health.

Insulin Pumps in the School Setting

A student in your school has diabetes and is on an insulin pump. An insulin pump is a device that continuously infuses a very small amount of fast-acting insulin through a small catheter under the skin. The student then takes additional insulin through the pump for meals and snacks. We would like to emphasize that problems and complications with insulin pumps are very seldom seen. For the most part, you will not be aware that the student is using the pump, although you may hear an occasional quiet beep or click when insulin is being dispensed by the pump. The following information may assist you in helping the student wearing an insulin pump.

Blood Sugar Testing

When a student is on an insulin pump, more frequent blood sugar testing may be necessary. If the testing can be done in the classroom, which would be preferred, as the student will miss less classroom time. Testing can also be done in the office or clinic if necessary.

Low Blood Sugar

If a student who is on an insulin pump experiences a low blood sugar reaction, these guidelines should be followed:

- ✓ If the blood sugar is between 50-70mg/dl, the student needs to take about 15 grams of carbohydrate, which is the equivalent to 4 oz. of juice, 3-4 glucose tablets, or 4 oz. of regular pop.
- ✓ If the blood sugar is less than 50mg/dl, the student may need to eat as much as 30 grams of carbohydrate (15 grams of one of the above in addition to 15 grams of a small snack, i.e., cheese crackers, or a granola bar).

- ✓ If the student should experience a severe low blood sugar where the student is unconscious or is having a convulsion, 911 should be called or Glucagon may be given by appropriately trained staff. **The pump should not be removed and the pump dosage should not be adjusted in any way.**

High Blood Sugars

High blood sugars over 300mg/dl may be an early indication that the pump is not infusing the insulin as it should or that the child is ill. If the student's blood sugar is over 300dl at mealtime, urine ketones should be checked. If the urine ketones are negative, the student can give an additional insulin dose through the insulin pump along with the usual lunch insulin dose. The student should then recheck a blood sugar in 1 hour to be sure it is coming down. If the blood sugar is above 300mg/dl and the ketones are small, moderate, or large, the student will need to be given an insulin dose with a syringe and drink 8 oz. of water an hour until the ketones disappear. The student will also have to change the infusion site and tubing for the insulin pump. The student should have a vial of fast-acting insulin and insulin syringes available in the clinic in case they need to give an additional injection.

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Exercise

During times of vigorous exercise, the student may need to disconnect from the pump. For this, the student needs to place the pump in a safe place where it will not be damaged. During prolonged exercise, many students reconnect the pump periodically and take insulin. Some students wear their pump during exercise and use a special case to protect it.

Questions?

If you have any questions, speak with the student and the student's family. They can be a tremendous resource for you. You may also contact the pump manufacturer for resource information for school health personnel.

Used with permission from: Insulin Pumps in the School Setting © 2001, The Children's Diabetes Self-Management Education Program, The Children's Mercy Hospital & Clinics, Kansas City, MO. All rights reserved.

Guidelines for Troubleshooting Insulin Pumps in the School

Any child with diabetes is at risk for both hypoglycemia (low blood sugar level) and for hyperglycemia (extreme high blood sugar levels) with or without ketones. This is no different for a child who wears an insulin pump. It is important for school personnel to know how to treat these two problems if they should occur. The pump does not need to be disconnected.










Hypoglycemia (Low Blood Sugar)

- Symptoms may occur rapidly with or without noticeable signs and symptoms.
- Symptoms may vary from child to child and from one episode to another.
- There may be time when hypoglycemia occurs without an apparent cause.
- If symptoms are left untreated, they may progress to the inability to eat or drink, unconsciousness, tremors or seizure.

Possible causes of Hypoglycemia:

- Increased activity
- Delayed or skipped meal
- Inadequate meal
- Too much insulin

Common Signs and Symptoms of Hypoglycemia:

-  Pale
-  Shaky
-  Sweaty
-  Cranky/Irritable
-  Sleepy
-  Hungry
-  Confusion
-  Headache
-  Dizziness

Potential Causes of Hypoglycemia With Insulin Pump

Possible Cause	Action
Insulin Pump <ul style="list-style-type: none"> ■ Basal rate programmed incorrectly ■ Clock time incorrect on display 	<ul style="list-style-type: none"> ■ Check times and basal rates ■ Reset clock
Food Intake <ul style="list-style-type: none"> ■ Bolus too large ■ Improper timing of insulin bolus 	<ul style="list-style-type: none"> ■ Check bolus amounts and times ■ Match timing of insulin with bolus Check blood glucose before meal

(list continued on next page)

Potential Causes of Hypoglycemia With Insulin Pump (continued)

Possible Cause	Action
Activity <ul style="list-style-type: none"> ■ Did not activate suspend or a temp basal rate ■ Food intake not adequate to accomodate exercise. ■ Unplanned activity 	<ul style="list-style-type: none"> ■ Consult with health care professional for guidelines to temporarily decrease rate for exercise ■ If not decreasing insulin for exercise, must eat carb containing food prior to exercise ■ Must check blood glucose prior to activity ■ Effects of exercise may be present for several hours after the exercise
Self-Monitoring of Blood Glucose <ul style="list-style-type: none"> ■ Infrequent blood glucose testing ■ Hypoglycemia unawareness 	<ul style="list-style-type: none"> ■ Check blood glucose a minimum of four times per day ■ May need to raise blood glucose goals

TREAT HYPOGLYCEMIA IMMEDIATELY!!

Use “Rule of 15”

Consume 15 grams of fast-acting carbohydrate

Wait 15 minutes

Recheck blood glucose

If blood glucose is <90 mg/dl, repeat above steps.*

THERE IS NO NEED TO DISCONNECT PUMP!!

If a child cannot take food by mouth, give GLUCAGON by injection. Turn the child on his/her side to prevent aspiration in the event of vomiting.

Treat the condition first, and then call the **medical team** and the parents. The school’s plan of care should indicate how hypoglycemic episodes are to be reported to a parent.

Since eating disorders can be a problem, the student should be referred back to the registered dietitian and primary provider if a pattern becomes apparent. At point of service, the student should be counseled about adequate intake and carrying a sugar source.

*While 90 mg/dl is certainly not considered low blood sugar, due to the volatility of blood glucose levels in type 1 children related to changes in activity and variations in insulin absorption, 90 can drop to <60 very quickly.





Hyperglycemia (High Blood Sugar)

- High blood sugar occurs due to an imbalance of food, exercise and insulin. Although not desirable, there is no immediate problem caused by mild hyperglycemia.
- This could happen in any child or teen with diabetes.

Possible causes of Hyperglycemia:

- Illness
- Too much food
- Not enough insulin
- Decreased activity
- Increase in hormones
- Rebound from low blood glucose level

Common Signs and Symptoms of Hyperglycemia:

-  Increased thirst
-  Frequent urination
-  Fatigue
-  Blurred Vision

Potential Causes of Hyperglycemia With Insulin Pump

Possible Cause	Action
Infusion Site/Set* <ul style="list-style-type: none"> ■ Redness, irritation at site ■ Bump or nodule at infusion site ■ Needle inserted in area of friction ■ Air in tubing ■ Luer lock connection between cartridge/reservoir not tight ■ Insulin leakage at site ■ Not changing cannula every 2-3 days 	<ul style="list-style-type: none"> ■ Change infusion site/set ■ Rotate site, avoid these areas ■ Avoid waistline and friction areas ■ Prime air out of tubing ■ Check connection ■ Change site ■ Remember to bolus to fill cannula after site change
Insulin Pump <ul style="list-style-type: none"> ■ Basal rate programmed incorrectly ■ Pump is in SUSPEND ■ Pump malfunction ■ Pump alarms ■ Time/date programmed incorrectly ■ Occlusion alarm ■ Dead battery ■ Cartridge/reservoir empty 	<ul style="list-style-type: none"> ■ Check times and rates ■ Take pump out of SUSPEND ■ Call pump manufacturer customer service ■ Identify alarms, take action as outlined in User Manual ■ Change cartridge/reservoir and infusion set ■ Change batteries ■ Fill new cartridge/reservoir

* Site should be changed every 2-3 days or as recommended by health care professional. Notify health care professional with signs or symptoms of infection.

(list continued on next page)

Potential Causes of Hyperglycemia With Insulin Pump (continued)

Possible Cause	Action
Food Intake <ul style="list-style-type: none"> ■ Bolus insufficient or omitted ■ Improper timing of insulin bolus 	<ul style="list-style-type: none"> ■ Need to count carbohydrates ■ Consult healthcare professional
Activity** <ul style="list-style-type: none"> ■ Blood glucose >240 with ketones before exercise 	<ul style="list-style-type: none"> ■ Blood glucose will increase with exercise when ketones are present

****Do not exercise with ketones. Consult healthcare professional for exercise guidelines.**

The treatment of high blood sugar in a student with an insulin pump is to give a correction bolus, temporarily increase the basal rate, or possibly, exercise. If there is a pattern of high blood glucose at certain times of the day, the parent or clinician should be notified. If a pattern emerges, refer the student back to the registered dietitian to review carb sources and portion sizes.

SMART PUMPERS TIP When in doubt, change it out!!

For unexplained high blood glucose (>240 mg/dl two times in a row), change the cartridge/reservoir and infusion site and set; check the urine for ketones; and take fast acting insulin by syringe as directed by the health care professional.

Diabetic Ketoacidosis (DKA)

Ketones are produced when there is insufficient insulin. The body begins to break down body fat that produces ketones. As ketones increase in the blood and urine, the body becomes acidic, thus leading to a condition called Diabetic Ketoacidosis (DKA),

Symptoms of DKA may include:

- ✓ Moderate or large amounts of ketones in the blood and urine
- ✓ Nausea, vomiting, stomach pain
- ✓ Labored breathing
- ✓ Fruity breath
- ✓ Weakness
- ✓ Mental sluggishness, slowness to respond
- ✓ Loss of consciousness, coma

Source: The information in this section was obtained from Tricia Green, RN, CPNP, CDE with Animas Corporation and from *Pumper in the School*, a publication by MiniMed.

Insulin Pump Manufacturer Contacts:

Animas Corporation **1-877-YES-PUMP**

Disetronic Medical Systems, Inc. **1-800-280-7801**

Nipro Diabetes Systems, Inc. **1-888-647-7698**

Deltec, Inc.

1-800-826-9703

Medtronic MiniMed **1-800-MINIMED**

Dana Diabecare USA **1-866-DANATEC**



Disposing of Sharps Safely

Millions of individuals with serious health conditions manage their care at home. For example, people with diabetes use syringes and lancets to test their blood sugar every day. All this creates a lot of medical waste. What's the best way to handle this waste?

The best way to protect trash handlers and sewage treatment workers against disease and injury, and avoid attracting drug abusers looking for syringes to reuse, is to follow these guidelines for containment and disposal of sharps.

Containment

- Contain the sharps in your own home.
- Use a puncture-proof plastic container with tight-fitting screw top. A bleach bottle is good. Don't use glass because it can break. Coffee cans are not recommended because the plastic lids come off too easily. A red sharps container may be purchased at local pharmacies as well.
- Label the container clearly. Write "Contains Sharps" with a waterproof marker directly on the container or on masking tape on the container.
- Once a syringe or lancet is used, immediately put it into a container. Screw on the top. Don't clip, bend or recap the needles because of potential injury to yourself.

- Keep the container away from children!
- When the container is full, screw on the cap tightly. Seal it with heavy-duty tape to be extra safe.

Disposal

There are different options for getting rid of the container of sharps. Some cities and towns have more options than others do. Here are the best ways for safety, health, and protection of the environment.

- Call local doctors, pharmacies, clinics, local hospitals, or nursing homes and ask if they accept properly contained sharps for disposal. Ask local diabetes educators or local American Diabetes Association office about sharps disposal programs.
- Call local public works department or solid waste manager. (Check the blue pages of the telephone book for their numbers.) Some communities have special household medical waste collection or drop-off days.
- Call local health departments and ask about special household medical waste disposal programs.

Consult your local department of public works for information about laws applying to disposal of household sharps along with household trash.

Oral Agents for Type 2 Diabetes

Drug Class	Generic Name	Trade Name	When to take	Usual Dosage	Max. Dosage	Peak	Duration	Side Effects
Alpha-Glucosidase	Slows down carbohydrate absorption in intestines							
	Acarbose	Precose	With first bite of food	25mg 3 X day	100 mg 3 X day	1 hr.	2-4 hr.	Abd. Pain Diarrhea Flatulence
	Miglitol	Glyset	With first bite of food	25 mg 3 X day	100 mg 3 X day	2-3 hr.	Unknown	Same as above
Biguanides	Decreases hepatic glucose production							
	Metformin	Glucophage	With Meals	500 mg 3 X day	850 mg 3 X day	UNK	Unknown	Diarrhea Nausea/vomiting Metallic Taste in Mouth
	Meformin (long acting)	Glucophage XR	With Meal	500 mg daily	2000 mg daily	UNK	Unknown	Same as Above
Meglitinides	Stimulates insulin release from pancreas							
	Nateglinide	Starlix	10 min. before meals	120 mg 3 X day	None given	1-2 hr.	4 hrs.	Gastric Upset Rash Upper Resp. Inf.
Sulfonylureas	Stimulates insulin release from pancreas							
	Repaglinide	Prandin	30 mins. Before meals	0.5 mg 2-4 X daily	4 mg 2-4 X daily	1 hr.	Unknown	Ischemia
	Acetohexamide	NONE listed	Before meals	250 mg daily	1500 mg daily	3 hr.	12-24 hr.	Ischemia
	Chlorpropamide	Diabinese	With Breakfast	250 mg daily	750 mg daily	2-4 hr.	24 hr.	Leukopenia
	Glimepiride	Amaryl	With first Meal	1-2 mg daily	8 mg daily	2-3 hr.	> 24hr.	Same as Above
	Glipizide	Glucotrol	Before Breakfast	5 mg daily	15 mg daily	1-3 hr.	4 hr.	Same as Above

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Drug Class	Generic Name	Trade Name	When to take	Usual Dosage	Max. Dosage	Peak	Duration	Side Effects
Sulfonylureas - continued	Glipizide (long acting)	Glucotrol XL	Before Breakfast	5 mg daily	20 mg daily	6-12 hr.	24 hr.	Same as Above
	Glyburide	DiaBeta, Micronase	With Breakfast	1.25 mg daily	20 mg daily	4 hr.	24 hr.	Same as Above
	Glyburide (micronized)	Glynase Pres Tab	With Breakfast	0.75 mg daily	12 mg daily	4 hr.	24 hr.	Same as Above
	Tolazamide	Tolinase	With Breakfast	100 mg daily	1000 mg daily	4-6 hr.	14-16 hr.	Same as Above
	Tolbutamide	Orinase	Take in Morning	1 gram daily	3 grams daily	1 hr.	5-8 hr.	Same as Above
Thiazolidinediones (TZDs)	Improves peripheral insulin sensitivity							
	Pioglitazone	Actos	Once Daily	15 mg daily	30 mg daily	2 hr.	Unknown	Headache Edema Anorexia
	Rosiglitazone	Avandia	Take in Morning	4 mg daily	8 mg daily	1 hr.	Unknown	Same as Above
Combination Pills								
	Metformin + Glyburide	Glucovance	With Meals	1.25/250 mg. daily	20/2000 mg daily	2 weeks	Unknown	Headache Dizziness
	Metformin + rosiglitazone	Avandamet	With Meals	1/500 mg daily	8/2000 mg daily	1 hr.	Unknown	Headache Diarrhea
	Metformin + Glipizide	Metaglip	With Meals	2.5/250 mg daily	5/500 mg daily	UNK	Unknown	Headache Diarrhea Hypertension Dizziness N & V

Adapted from: *Diabetes Forecast*, 2004 Resource Guide, Volume 57, Number 1, Page RG 13.

Effects of Over-the-Counter and Prescription Medications on Diabetes Control

I. Drugs that may Alter Glycemic Effect of Sulfonylureas

A. Enhance hypoglycemic effect (decrease blood glucose)

1. Alcohol (acute use)
2. Allopurinol (Zyloprim)
3. Androgens
4. Anticoagulants (Coumadin)
5. Chloramphenicol
6. Clofibrate (Atromid-S)
7. Fenfluramine
8. Fluconazole
9. Gemfibrozil
10. Histamine H₂ antagonists (Pepcid, Tagamet, Zantac)
11. Magnesium salts
12. Methyl dopa
13. Monoamine oxidase (MAO) inhibitors (Nardil, Parnate, Marplan)
14. Phenobarbital (Donnatal)
15. Phenylbutazone
16. Probenecid
17. Salicylates (aspirin, Disalcid, Dolobid)
18. Sulfapyrazone
19. Sulfonamides, (Bactrim, Gantrisin, Septra)
20. Tricyclic antidepressants (Elavil, Pamelor, Tofranil, Triavil)
21. Urinary acidifiers

B. Decrease hypoglycemic effect (increase blood glucose)

1. Alcohol (chronic use)
2. Beta-blockers (can have either hypo or hyperglycemic effect)
3. Cholestyramine
4. Diazoxide (Proglycem)
5. Diuretics (Diuril, Hydrodiuril, Lasix, Lozol)
6. Hydantoin (Dilantin)
7. Rifampin
8. Urinary alkalinizers
9. Charcoal

II. Drugs that Interact with Insulin

A. Enhance hypoglycemic effect (decrease blood glucose)

1. Angiotensin-converting enzyme (ACE) inhibitors
2. Alcohol
3. Anabolic steroids
4. Beta-blockers (delay recovery from hypoglycemia)
5. Calcium
6. Chloroquine
7. Clofibrate
8. Fenfluramine
9. Guanethidine
10. Lithium carbonate
11. MAO inhibitors
12. Mebendazole
13. Octreotide
14. Pentamidine
15. Phenylbutazone
16. Pyridoxine
17. Salicylates
18. Sulfapyrazone
19. Sulfonamides
20. Tetracyclines

B. Decrease hypoglycemic effect (increase blood glucose)

1. Acetazolamide
2. AIDS antivirals
3. Asparaginase
4. Calcitonin
5. Contraceptives, oral
6. Corticosteroids
7. Cyclophosphamide
8. Dextrothyroxine
9. Diazoxide
10. Diltiazem
11. dobutamine
12. Epinephrine
13. Estrogens

- 14. Ethacrynic acid
- 15. Isoniazid
- 16. Lithium carbonate
- 17. Morphine sulfate
- 18. Niacin
- 19. Phenothiazines
- 20. Nicotine
- 21. Thiazide diuretics
- 22. Thyroid drugs

III. RULES FOR PATIENT USE

- A. ALWAYS read the medication label (take note of caution and warning labels)
- B. ASK your pharmacist when in doubt about interaction of medications.
- C. AVOID medication products containing sugar (corn syrup, dextrose, glucose, sucrose, and fructose).
- D. AVOID medication products containing alcohol; if consumed, the smaller the percentage the better.
- E. AVOID salicylates in large doses unless prescribed by physician.

Ballard AM, 2000. *Medication Effects*. The Diabetes Ready-Reference Guide for Health Care Professionals. American Diabetes Association.©